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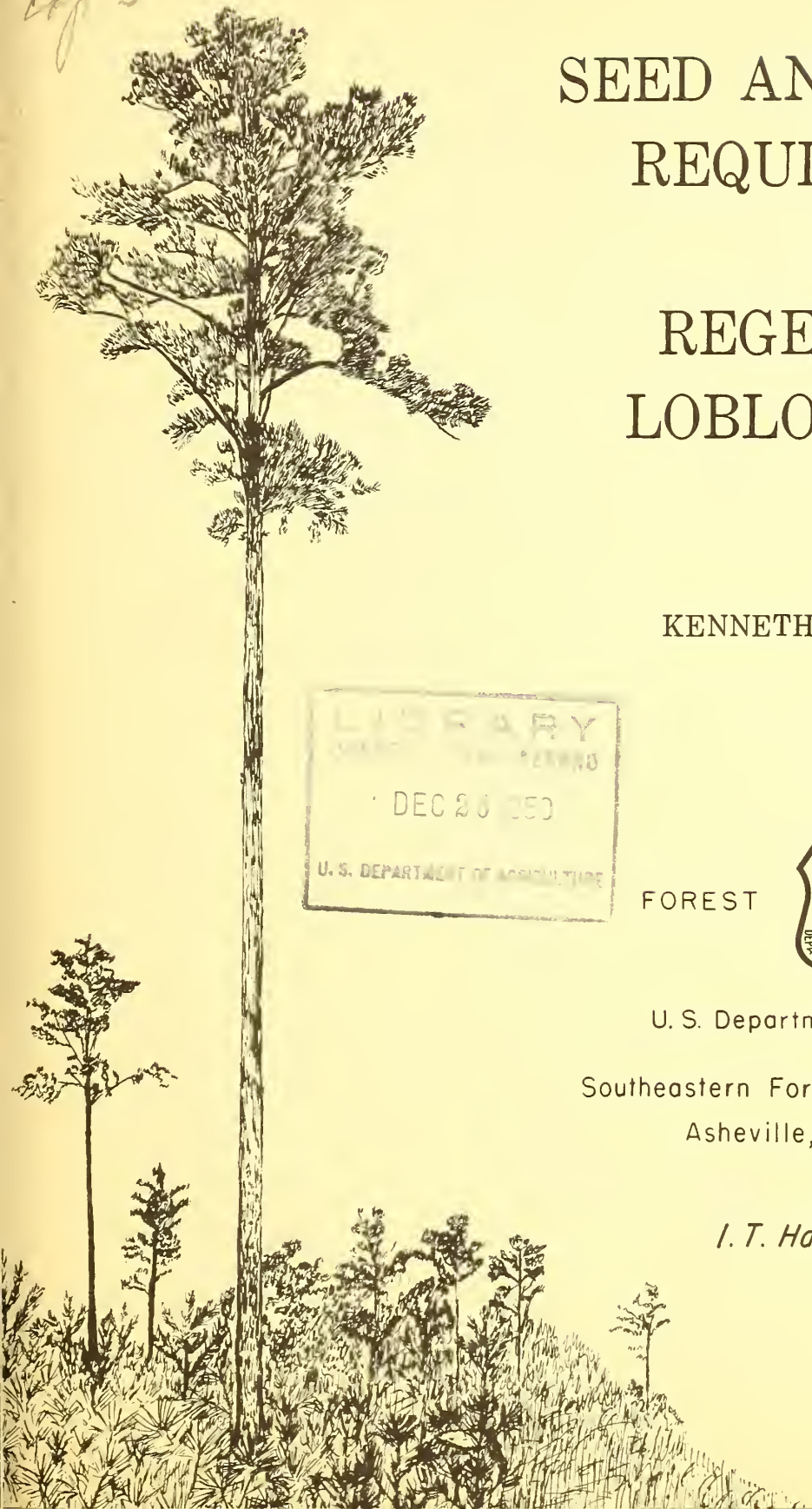

SEED AND SEEDBED REQUIREMENTS TO REGENERATE LOBLOLLY PINE

BY

KENNETH B. TROUSDELL

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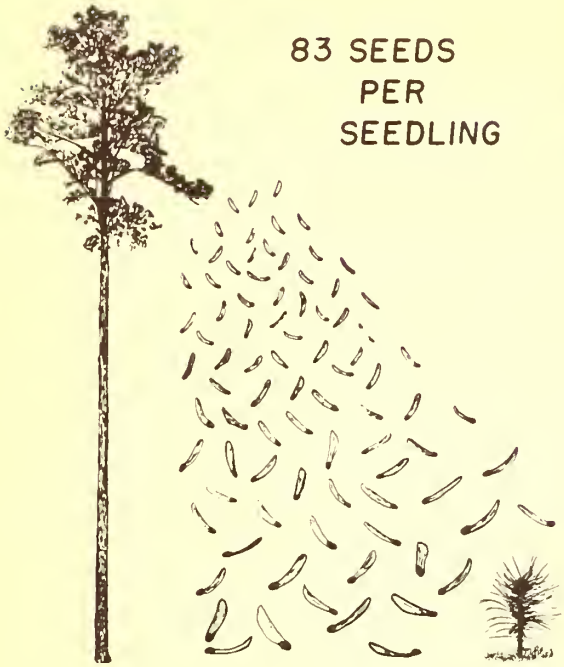
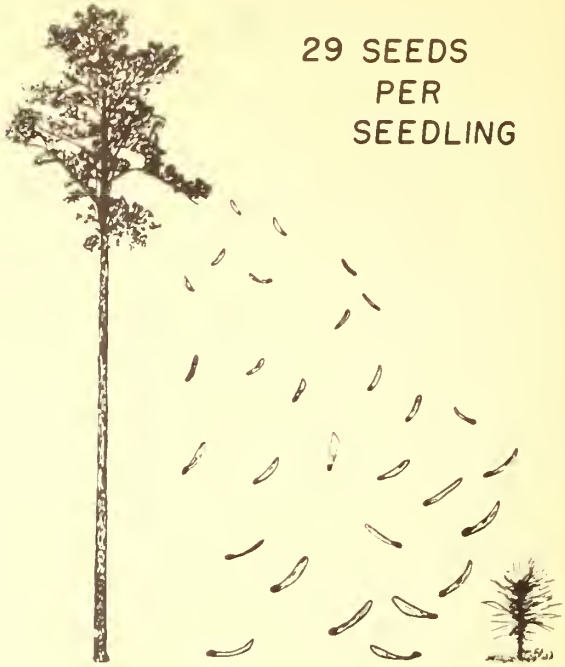
ON SLASH

83 SEEDS PER SEEDLING



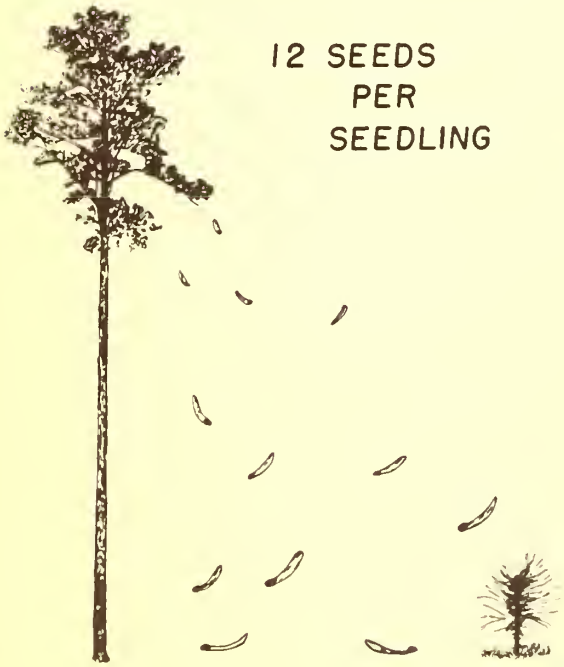
ON UNDISTURBED SURFACE

29 SEEDS PER SEEDLING



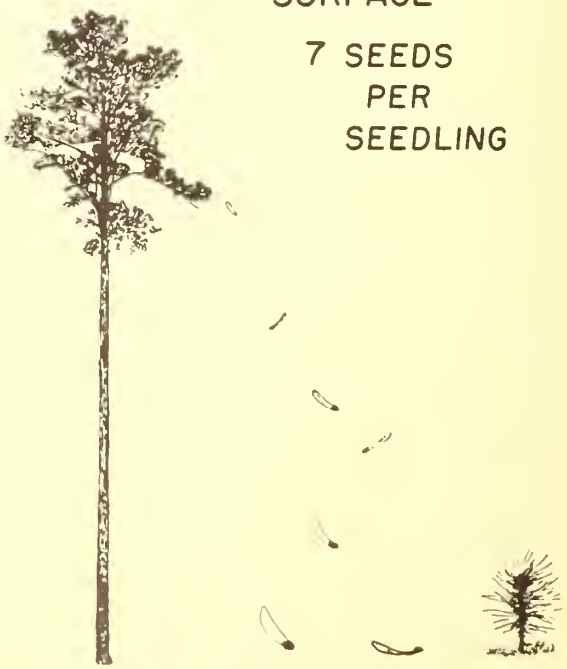
ON BURNED SURFACE

12 SEEDS PER SEEDLING



ON LOGGED AND DISKED SURFACE

7 SEEDS PER SEEDLING



Number of seeds needed to establish one seedling on different classes of seedbed.

SEED AND SEEDBED REQUIREMENTS TO REGENERATE LOBLOLLY PINE

by

Kenneth B. Trousdell

The reproduction of loblolly pine is too complex a process to be explained successfully by post-mortems held over areas on which seedlings have or have not become established. Variations in seed supply, seedbed condition, and number, species, and size of hardwoods ordinarily confuse the observer. A better basis for judgment is developing from studies on experimental forests where careful observations before and after cutting supplement the results of more fundamental investigations. The purpose of this paper is to summarize the observations made on compartments in the Bigwoods Experimental Forest[1/] as an aid to improvement in methods of reproduction cutting and seedbed preparation.

A better understanding of loblolly seedling establishment can be had by considering it the result of three inter-related processes. These are: (1) provision for seed, (2) germination and early survival, and (3) competition with surrounding vegetation. The present discussion will be limited to the first two because detailed information about competition has not yet been obtained. In places where the need for removal of competition is obvious, methods have been developed that are suitable for large-scale application (2).

1/ Maintained by the Southeastern Forest Experiment Station in cooperation with Camp Manufacturing Company, Inc., Franklin, Virginia.

FUNDAMENTAL INFORMATION

Loblolly pine has been found to produce seed crops varying greatly in magnitude from year to year. Soundness of the seed increases in general as the size of the seed crop increases (4). There is also great variation in seed production between individual trees. Large trees and those with abundant old cones in the crown are usually the most prolific seed trees (5). Studies have shown that trees released for three growing seasons produce greatly increased volumes of high-quality seed even in years of generally poor cone production (4,5,7). The possibility of correlating reproduction cutting with seed supply through cone-crop estimates and release cuttings has also been pointed out (7).

It has been repeatedly shown that mineral soil is the most favorable seedbed for loblolly pine. Recent studies by Grano (3) and Pomeroy (6) showed that soil and litter conditions found after logging or burning have a direct bearing on the number of seeds that will germinate. Grano's work was on field plots in a selection forest in Arkansas, and Pomeroy's was a controlled greenhouse study. Both show that exposed mineral soil is the best seedbed, and logging slash the poorest. Undisturbed litter comes somewhere in between. Pomeroy also found that burned areas provided more favorable conditions for germination than were found on undisturbed litter, but burns were not as good as logged areas.

REPRODUCTION CUTTINGS IN THE BIGWOODS EXPERIMENTAL FOREST

Use has been made of the available fundamental information in making plans for studies of loblolly pine regeneration in the Bigwoods. Reproduction cutting has been completed on about 350 acres with soils ranging from sandy loams to heavy silt loams. Seed traps provide an estimate of seedfall, and milacre plots are used to gauge the seedling catch. Good seedbeds have become well stocked when small amounts of seed were available. Poor and mediocre seedbeds have become fairly well stocked with reproduction following a bumper seed crop.

Ground has been prepared before seedfall in three ways: by logging with a crawler tractor and arch; by disking before logging, using a bush and bog harrow; and by broadcast burning when the slash has cured after logging. After treatment, each logging unit is sampled to determine the percentage of the area in each of the following seedbed classes: disturbed, burned, undisturbed, and slash. The plots established for later reproduction surveys are similarly classified. Average conditions for each method of seedbed preparation are given in table 1.

Table 1.--Seedbed classes resulting from three methods of site preparation

Site preparation	Seedbed classes[1/]			
	Disturbed	Burned	Undisturbed	Slash
	Percent	Percent	Percent	Percent
Logged	49	0	31	20
Logged and burned	35	49	15	1
Disked and logged	79	0	4	17

1/ Disturbed is classed as a very good seedbed, burned as good, undisturbed as fair, and slash as poor.

Following the first growing season after logging, reproduction is tallied by seedbed condition. Seedling counts have been made at the end of each of the past three growing seasons. This reproduction tally and the estimate of seedfall from seed traps then provide the basis for an estimate of the number of sound seeds needed to produce a seedling. The number of seed has fluctuated within narrow limits for the very good (disturbed) seedbed, and over wider limits as the seedbed gets progressively poorer. For plots classified as very good the range of seeds needed to establish a seedling has been from 3.8 to 8.7, with 6.6 as the weighted average. For burned plots the range was 5.3 to 13.3, with 11.6 as the average. For undisturbed plots the variation was between 5.5 and 54.3, with an average of 29.3. For slash plots there was a complete blank on two logging units, and on three others the number of seeds per seedling ranged from 32.0 to 96.9, with 83.2 as the average. A graphic means of predicting the number of seedlings per acre that will become established on a given type of seedbed from a known volume of seed is shown in figure 1.

The number of seedlings needed to assure full stocking has not been determined for loblolly pine. The stocked quadrat method of estimating stocking provides a base figure, however, to which estimates of adequacy can be referred. It is used here for convenience, with "full stocking" indicating one or more seedlings established in each sample milacre.

The distribution of seedlings on a uniform seedbed after uniform seed distribution is purely random. Losses during the first season may disturb that even distribution of seedlings. In the Bigwoods, disturbances from this source apparently are not serious, because variation in the stocking obtained from a given number of seedlings is limited to a very narrow range.

In the Bigwoods, where heavy equipment covers the

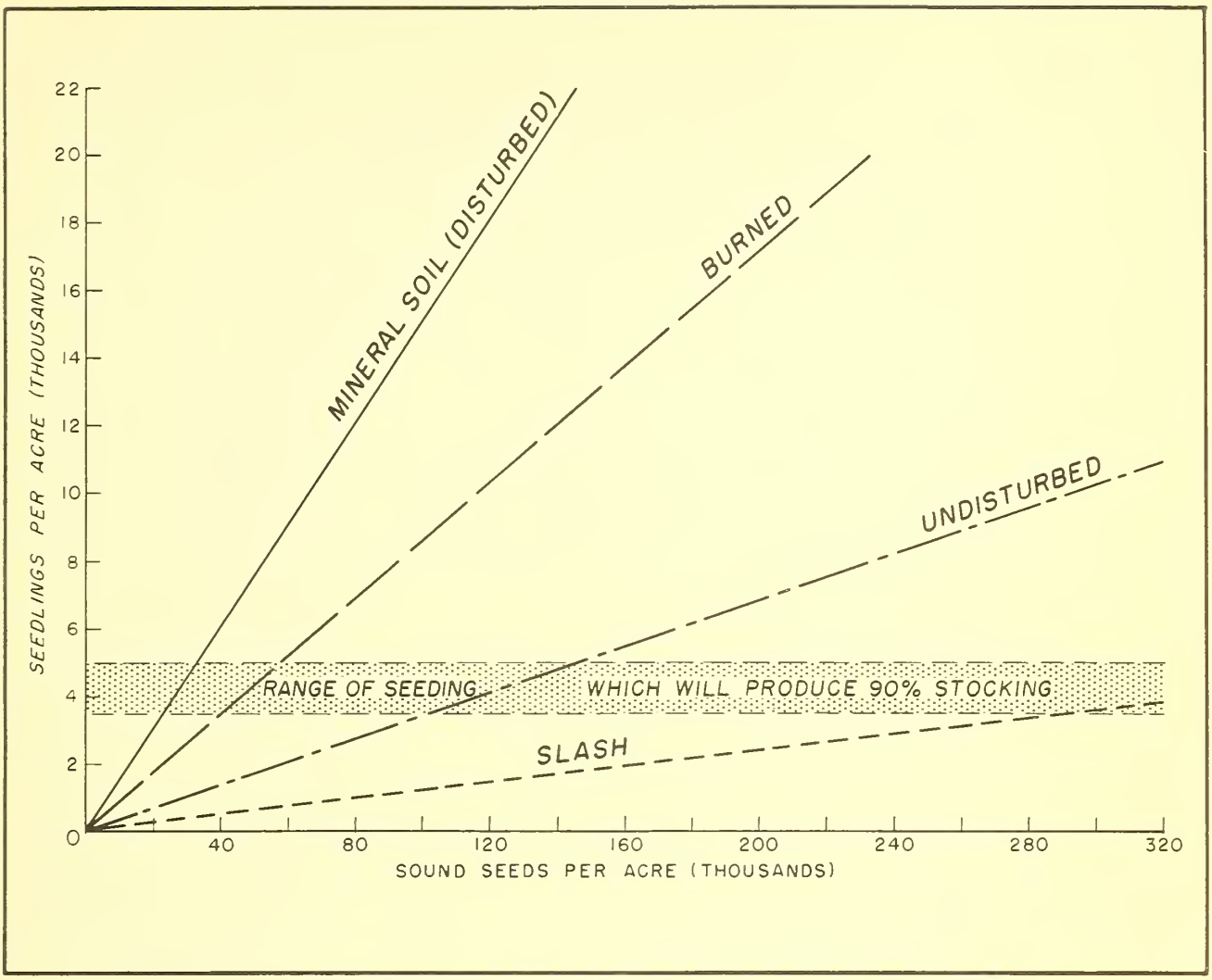


Figure 1.--Number of seedlings produced from various amounts of sound seed by four classes of seedbed.

logging unit thoroughly to remove large volumes, the stocking achieved with a given number of seedlings is only 5 to 10 percent less than on a uniform seedbed (fig. 2). Where lesser volumes are logged, and by other types of equipment, the variation in stocking may be greater.

PROVIDING AN ADEQUATE SEED SUPPLY

The number of sound seed per acre produced by seed strips or scattered seed trees in the Bigwoods has ranged in a period of four years from 4,000 to 146,000. Because this mature seed source during that period has not furnished enough seed to heavily stock undisturbed areas and slash piles, the practical goal of management should probably be to provide a seed source that will stock a seedbed of exposed mineral soil at a fairly high level. In the absence of well-founded rules for stocking, a stand of reproduction which will have one seedling or more on 90 percent of sample milacres is suggested as a good target. For Bigwoods soil conditions, which are fairly typical of a large portion of the Virginia and North Carolina coastal plain, this would require 3500 to 5000 seedlings per acre (fig. 3). The seed supply needed to produce that many seedlings the first growing season on a disturbed seedbed ranges from about 20,000 to 37,000 per acre (fig. 1).

What type of seed source is fairly certain to produce this minimum volume of seed? The answer involves the age of the timber, its previous cutting history, and selection of good seed producers (5). The story is not complete, but some approximations are available from the experimental forest records for large loblolly pine trees averaging 20 inches d.b.h. and 80 to 150 years old that grew in an undisturbed forest. The range of seeding shown in table 2 was secured from seed trap and inventory records. All seed trees selected

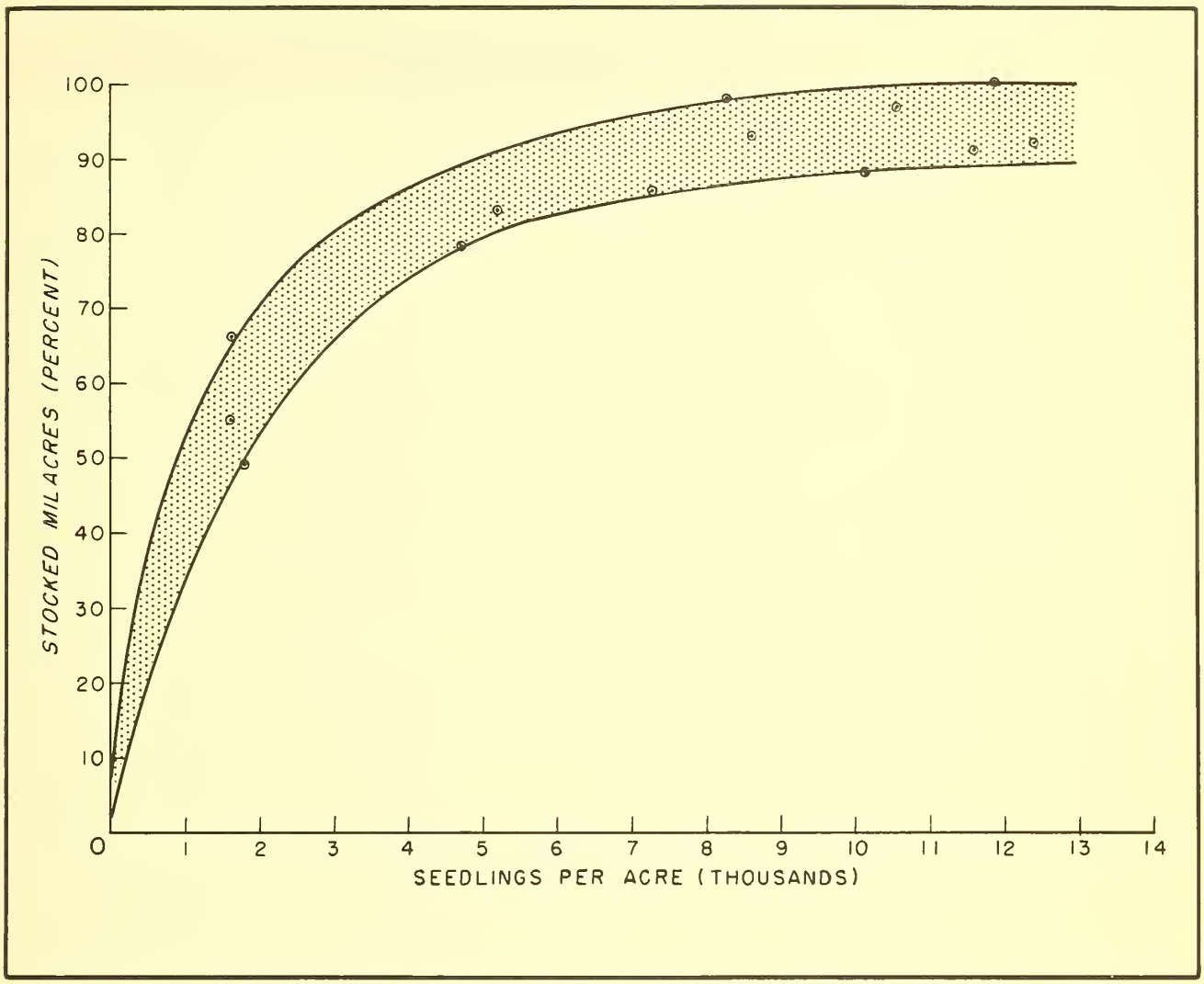


Figure 2.--Percent of sample milacres with one or more seedlings when compartment has given number of seedlings per acre. The band in the diagram shows the range of values observed in three years' tests.

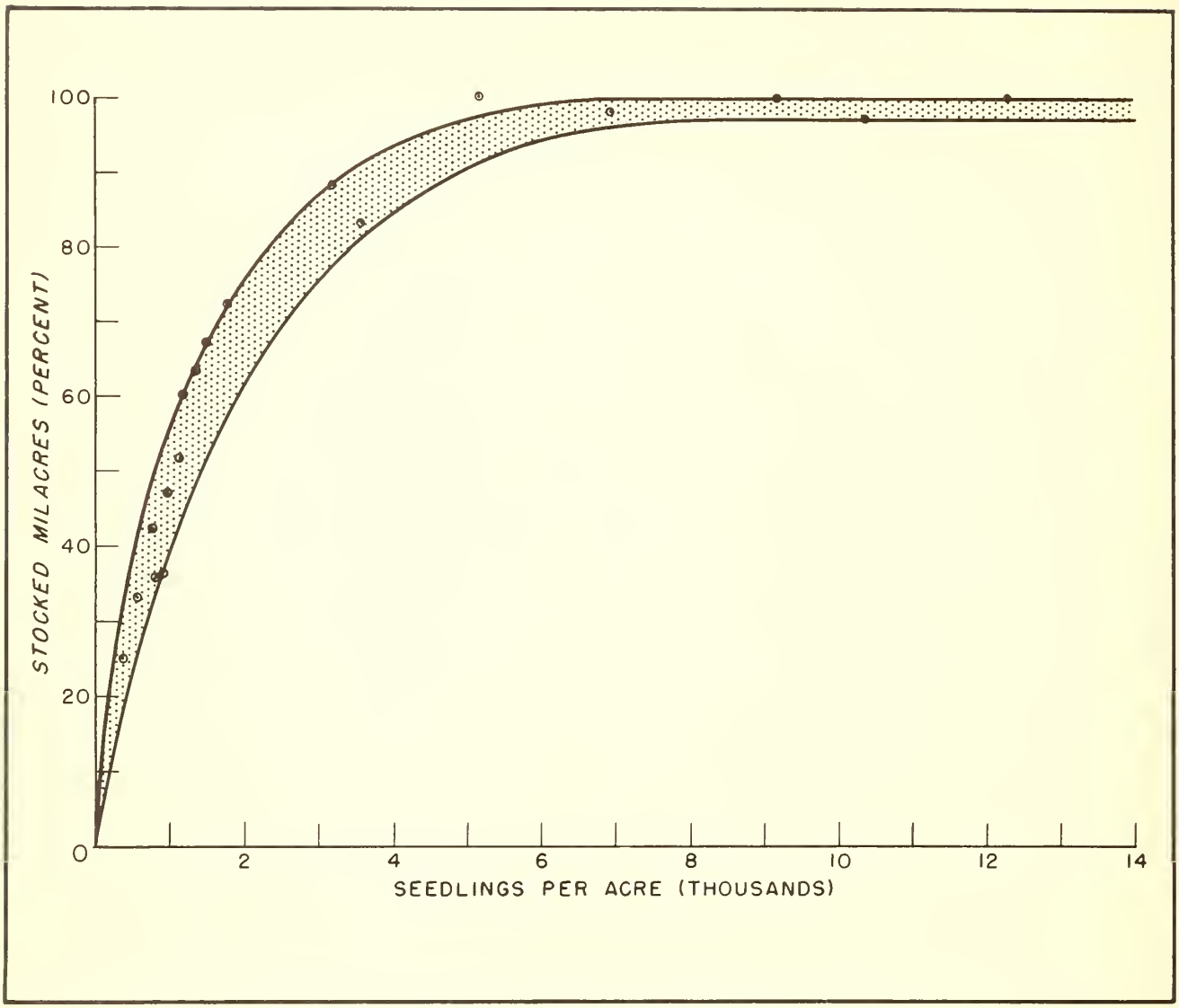


Figure 3.--Relation between number of 1-year-old seedlings per acre and percent stocking on any uniform seedbed. Full (100%) stocking occurs when every milacre has one or more seedlings. The band in the diagram shows the range of values observed in three years' tests.

as such are included, and seed-producing trees in strips, selection stands, and undisturbed stands were assumed to be all trees 14 inches d.b.h. and over (table 2).

Table 2.--Sound seed per tree by seed year and cutting history

Cutting history	1946	1947	1948	1949
	Thousand	Thousand	Thousand	Thousand
Not stimulated	8.9-13.1	7.9-14.1	0.3 - 0.6	1.3-2.4
Stimulated by release				
Following 3 growing seasons			9.0 -11.7	1/ 4.2
Following 4 growing seasons				14.7-20.8

1/ A selection forest dense in patches.

If 20,000 to 37,000 sound seed are required the first year to stock 90 percent of the best seedbed with seedlings, how many seed trees per acre were necessary on the experimental forest to produce this amount of seed? From table 2, in 1946 the best-producing stand (13.1 thousand sound seed per tree) would require but two trees, averaging 20 inches d.b.h., to furnish 20,000 sound seed. This will be called the minimum seed tree requirement for that year. The poorest producing stand (8.9 thousand sound seed per tree) would require five trees to produce 37,000 sound seed. This will be called the maximum seed tree requirement (table 3).

Table 3.--The minimum and maximum numbers of 20-inch Bigwoods seed trees needed to produce 20,000 and 37,000 sound seed per acre by years

Kind of seed trees:	1946		1947		1948		1949	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Not stimulated	2	5	2	5	33	123	9	29
Stimulated 3 yrs.					2	4	1/ 5	9
Stimulated 4 yrs.							1	3

1/ A selection forest.

Careful selection of the best seed trees is important but the seed crop from unstimulated seed trees will follow the general pattern of annual loblolly pine seed production. The annual fluctuation of loblolly pine seed production is large. Trees that have been stimulated by release have produced large crops during poor seed years.

The few records available for younger unreleased trees indicate that they are less dependable sources of seed. Selected 40-year-old trees near Courtland, Virginia, each produced 210 sound seeds in 1949. That year, seed trees in the Bigwoods produced 1300 to 2400 sound seed per tree. In other words, the seed production of a single Bigwoods tree equalled that from about ten of the 40-year-old trees. In that same year 76 percent of selected 25-year-old seed trees on a nearby tract had no cones on them at all.

From these records it is evident that seed will quite often be inadequate if portions of a previously uncut stand are left to produce it. Prior release of the seed trees through partial cuttings gives promise of encouraging seed production at the time it is needed (table 3). Another possibility is to plan reproduction cutting only in good seed years. If cutting cannot be deferred till a good seed year or till release of seed trees is effective, logging in the winter when the seed from the whole stand is on the ground may produce satisfactory reproduction.

Additional seed has much the same effect as added seedbed preparation on the percent stocking. A comparison can be made from table 4, which was prepared by combining the information shown in table 1, figure 1, and figure 2. If 30,000 sound seed are available, the percent stocking can be increased 11 percent, from 67 to 78, by disking before logging. Approximately the same result could be achieved by adding an extra 10,000 seeds. Consequently, the gauging of seed supply should become an increasingly important part of plans for successful first-year establishment of seedlings.

Table 4.--Percent stocking on three types of seedbed with variable amounts of seed

Sound seed	Stocking		
	Logged	Logged & burned	Disked & logged
Thousand	Percent	Percent	Percent
10	40	44	49
20	56	61	66
30	67	72	78
40	77	81	87
50	83	87	91

LOSSES OF SEED AND SEEDLINGS

An estimate of loblolly seed requirements made in 1940 set the minimum needed to assure full stocking at 200,000 to 300,000 per acre (1). These large amounts of seed were considered necessary to allow for anticipated heavy losses to birds, rodents, insects, and drought. During the past four years, however, there have been no excessive losses of this type in the Bigwoods. As observations are carried on over a longer period, a better evaluation of seed losses will be possible.

HARDWOOD CONTROL

Most of the treatments that are designed to improve the seedbed also reduce the amount of competition seedlings will have from hardwoods. Usually this dual purpose is recognized and the cost of the operation is charged off both to seedbed preparation and hardwood control. No effort has been made in this paper to evaluate hardwood control treatments, though studies of this problem are now in progress. From the evidence regarding seedbed preparation, however, it is likely that such costs as burning, disking, and bulldozing after cutting will have to be justified by the benefits in hardwood control alone, since extra seed has the same effect as seedbed preparation and is probably cheaper to provide. On the other hand, if regeneration of cutover areas is delayed for several years so that hardwoods become well established and a layer of litter develops on the forest floor, a combination treatment that will control hardwoods and prepare the seedbed may be necessary before pine will seed in.

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